A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

National Renewable Energy Laboratory

Innovation for Our Energy Future

Sustainable Transportation – Pathways to the Future

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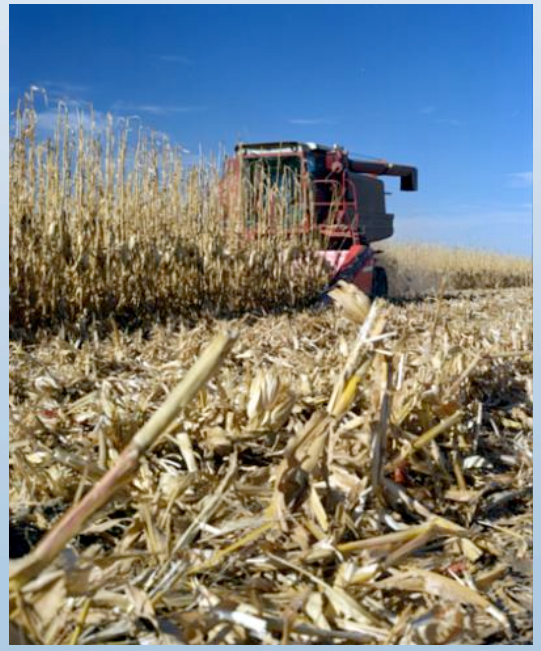


November 9, 2005

NREL is operated by Midwest Research Institute • Battelle

National Bioenergy Center

Sponsored by DOE - EERE
Office of the Biomass Program

Purpose:

- Help achieve DOE goals:
  - Reduce U.S. dependence oil
  - Build U.S. bioenergy industry
  - Reduce global warming
- Provide one-stop shopping for DOE's industrial partners
- Coordinate multi-year planning and execution of R&D at all DOE Labs
- Fully leverage tax-payer investment in federal facilities

"Virtual Center" created to improve DOE Lab collaboration in bioenergy research

NREL

ARGONNE NATIONAL LABORATORY
OPERATED BY THE UNIVERSITY OF CHICAGO

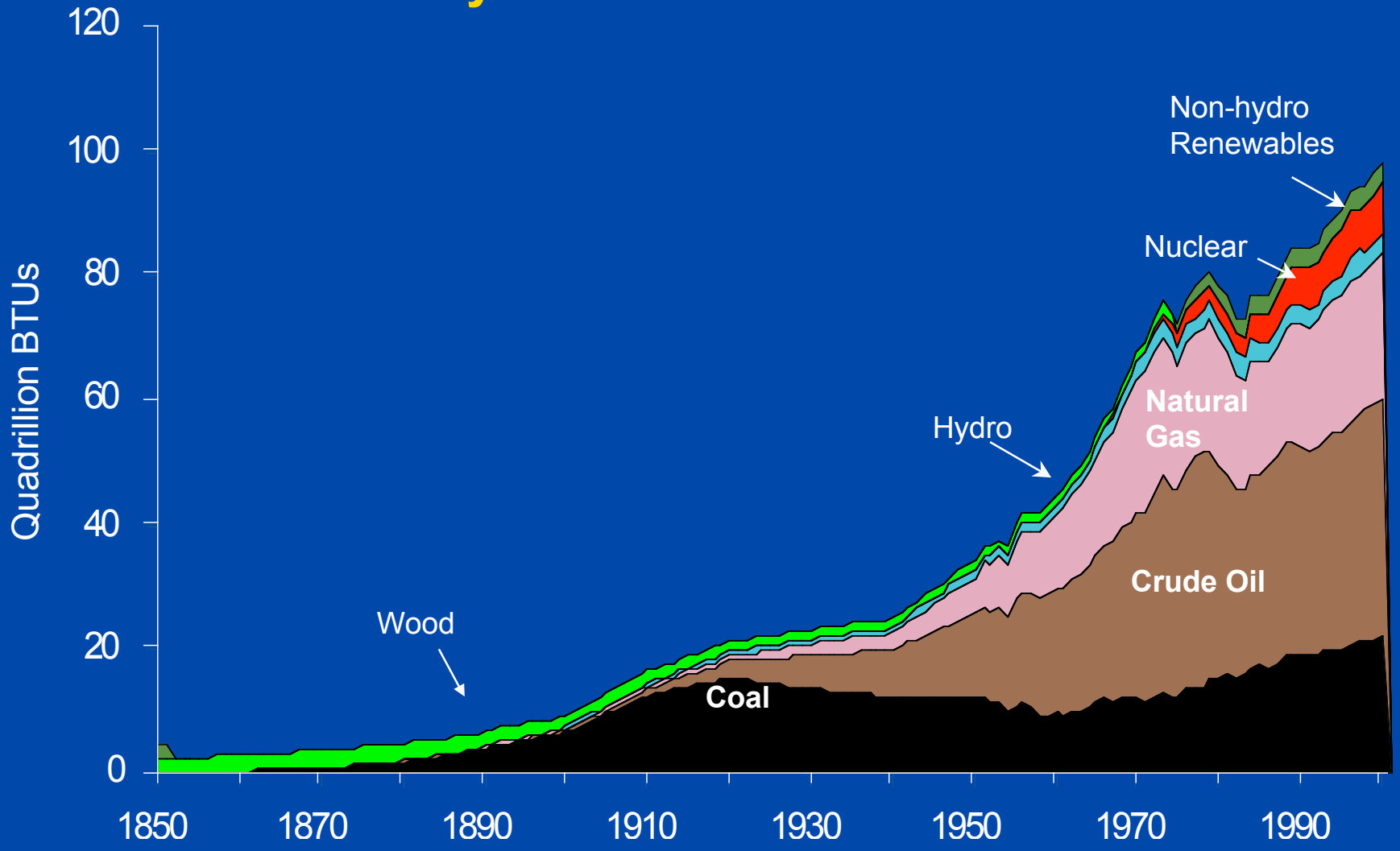
INEEL
Home of Science and Engineering Solutions

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

OAK RIDGE NATIONAL LABORATORY

History of U.S. Energy Consumption

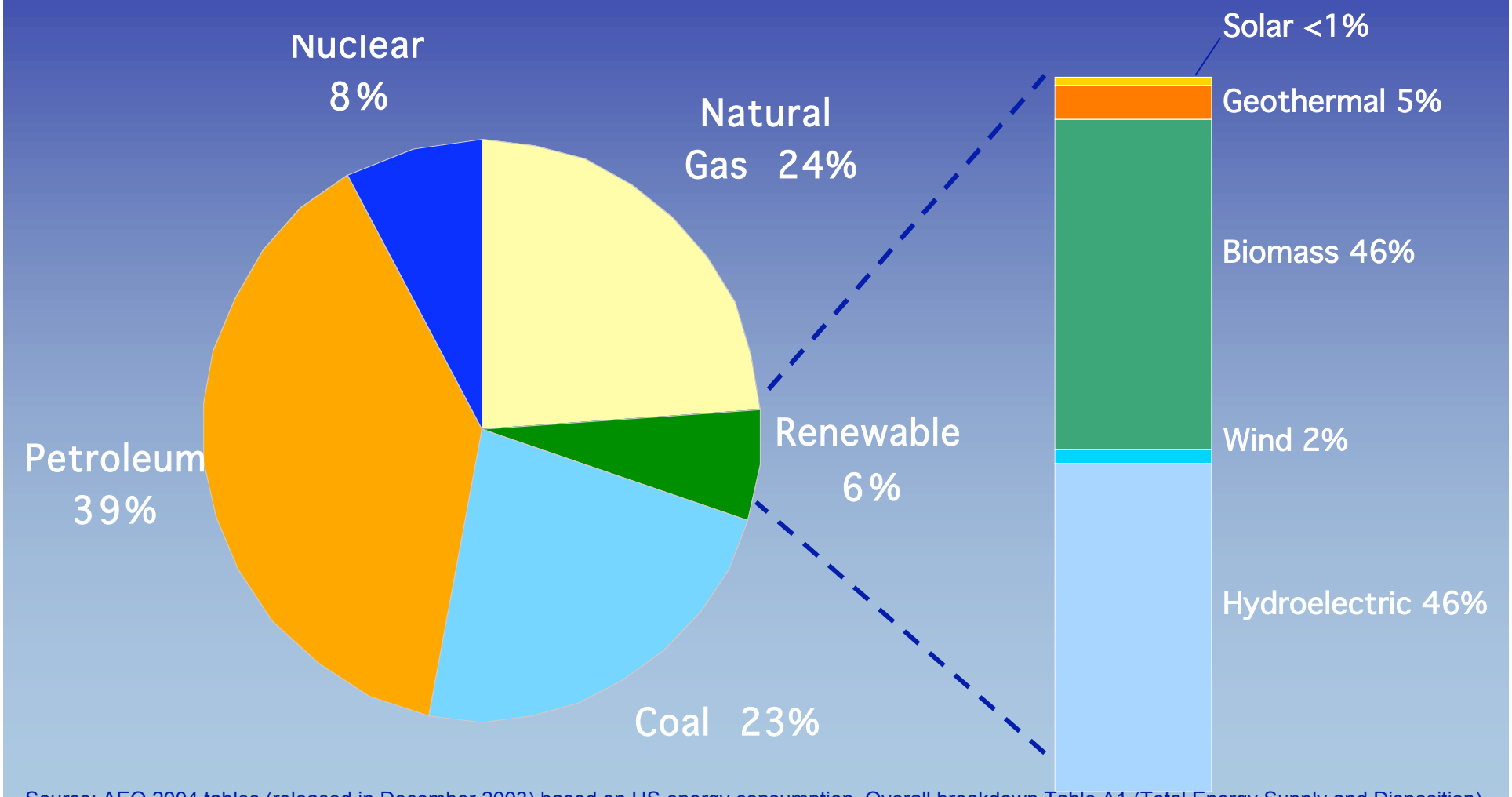
by source - 1850-2000



Source: 1850-1949, Energy Perspectives: A Presentation of Major Energy and Energy-Related Data, U.S. Department of the Interior, 1975; 1950-2000, Annual Energy Review 2000, Table 1.3.

Biomass Share of U.S. Energy Supply

(data for 2003)



Source: AEO 2004 tables (released in December 2003) based on US energy consumption. Overall breakdown Table A1 (Total Energy Supply and Disposition), and Renewable breakdown Table A18 (Renewable Energy, Consumption by Section and Source).

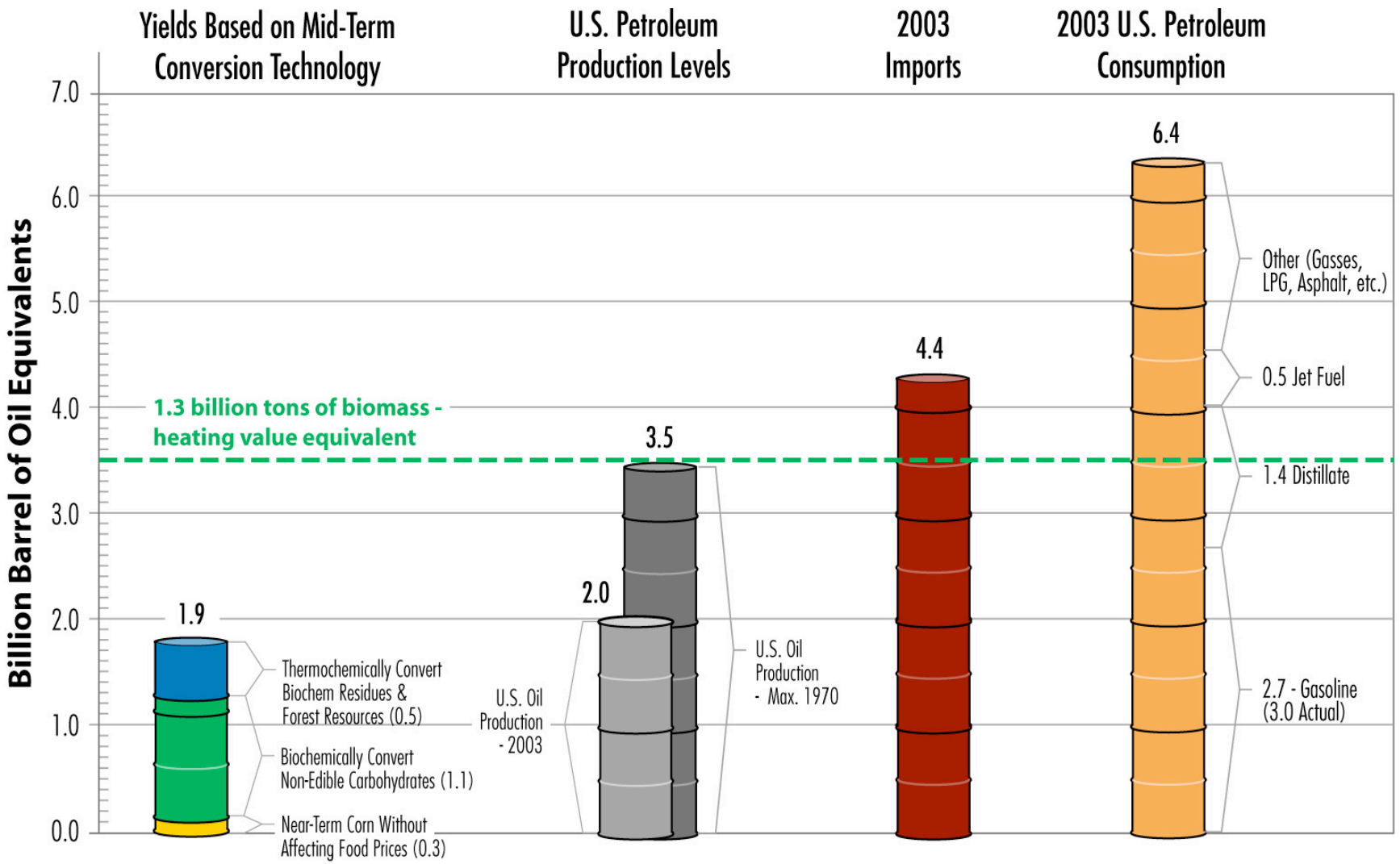
Benefits of Biomass

- Abundant
- Renewable
- Carbon-neutral
- Available worldwide
- Only sustainable source of hydrocarbons

Biomass can:

- Be used with the existing petroleum infrastructure
- Fill the gap between energy demand and petroleum availability.

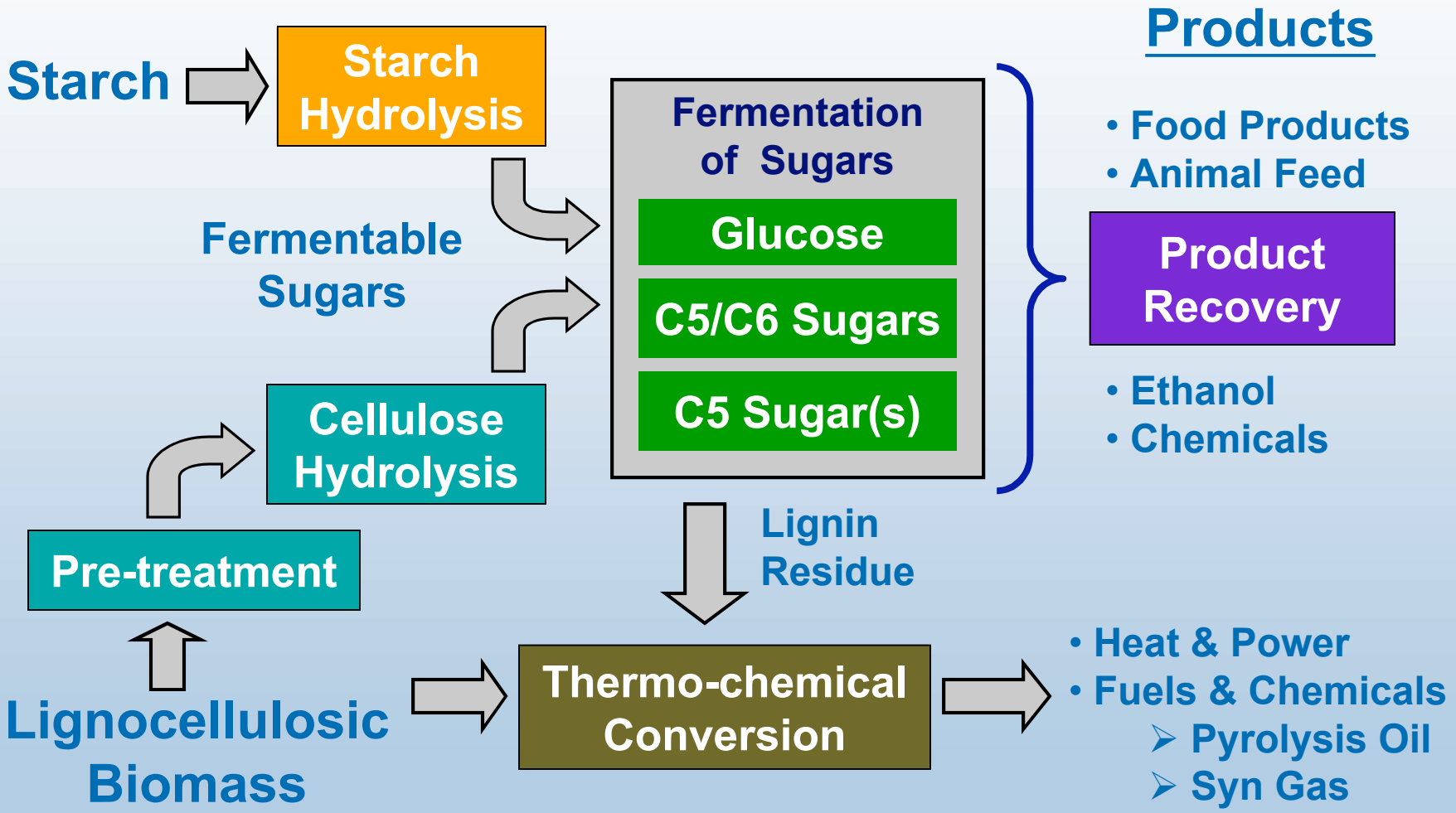
1.3 Billion Ton/year U.S. Biomass Supply Scenario



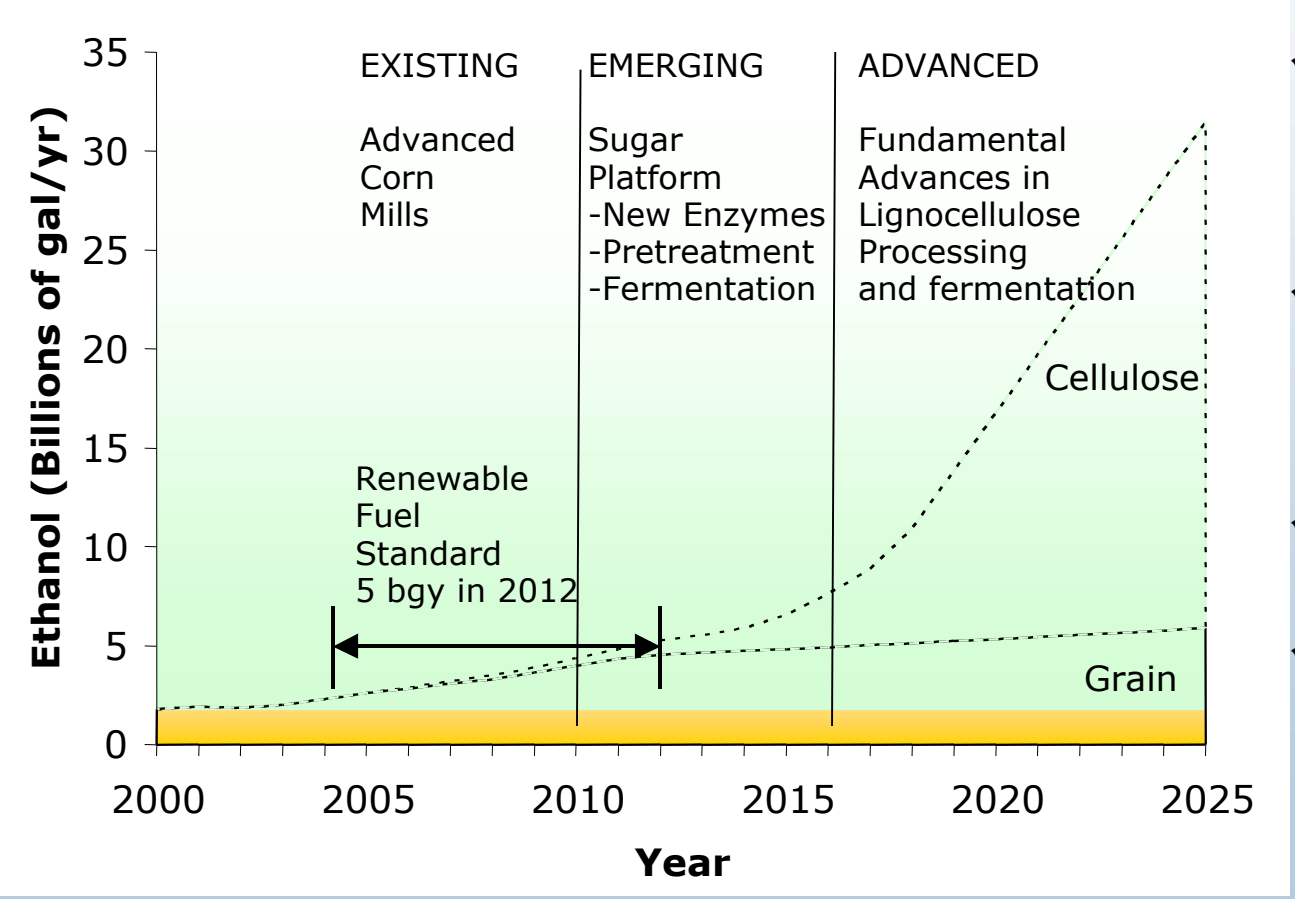
Based on ORNL & USDA Resource Assessment Study by Perlach et.al. (April 2005)
http://www.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf

Integration of Biorefinery Elements

Integrate starch & lignocellulose conversion



DOE Biomass Program Goal: A Vision of Oil Savings



- ✓ Existing and emerging technology supports targets of a renewable fuel standard
- ✓ Advanced technology provides the leap to substantial oil displacement
- ✓ Government role in high risk R&D
- ✓ Industry role is to commercialize

Integration of Bio-Renewables into Power Production and Petroleum Refining

Hydrogen – Key to Secure and Clean Energy Future

- **Energy Security**

Can be produced from a variety of domestic sources

- **Environmental**

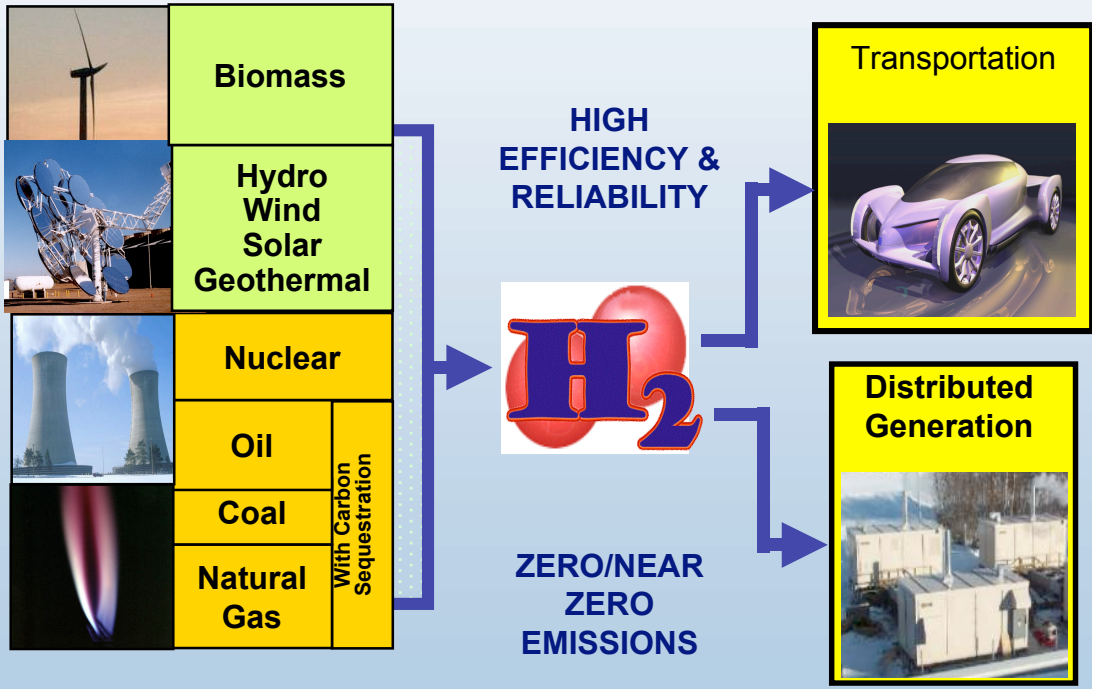
Criteria pollutants from mobile sources eliminated

Emissions from stationary H_2 production sites easier to control

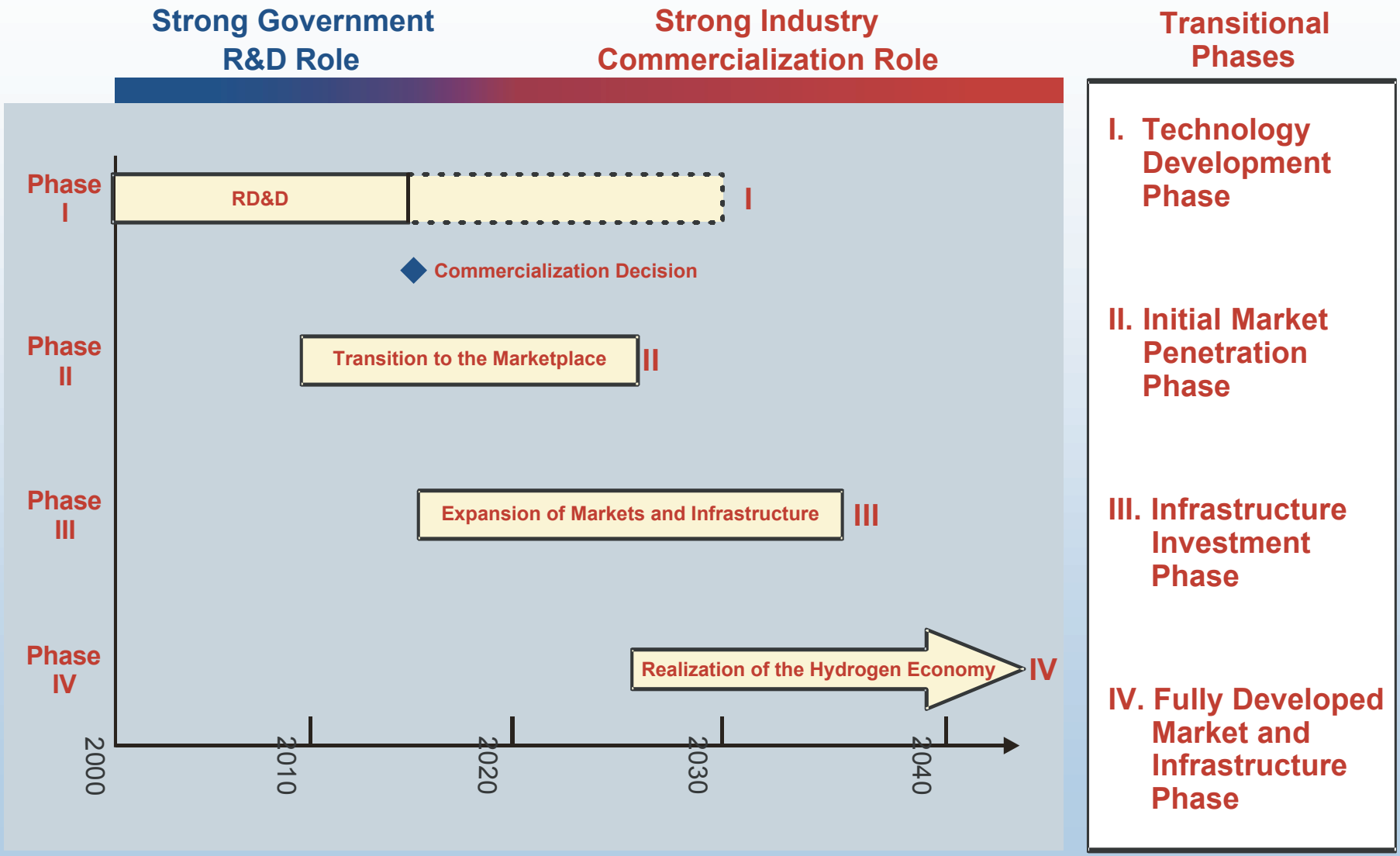
Greenhouse gas emissions significantly reduced

- **Economic Competitiveness**

Abundant, reliable, and affordable energy is an essential component in a healthy, global economy.



Timeline for Hydrogen Deployment



Barriers to Hydrogen Economy

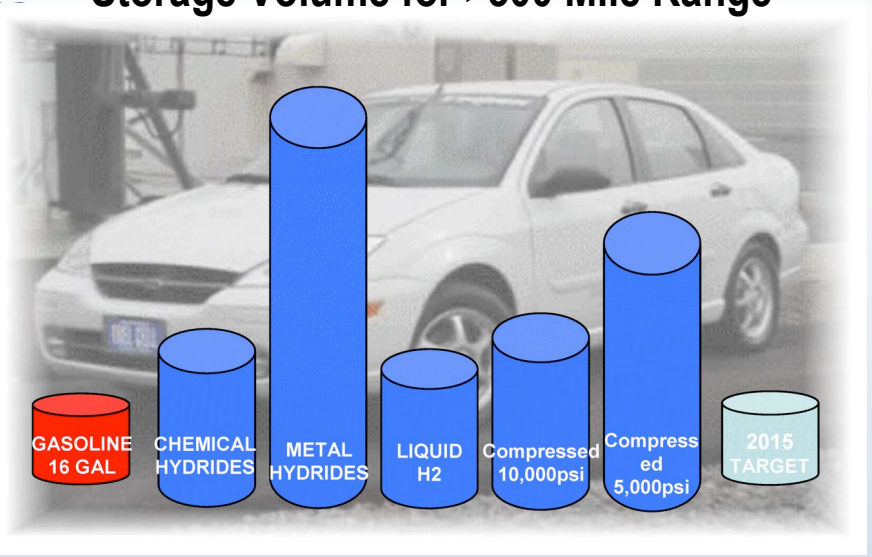
Critical Path Technology Barrier

- Hydrogen Storage (>300 mile range)
- Hydrogen Production cost ($1.50 - 2.00 per gge)
- Fuel Cell cost (<$50 per kW)

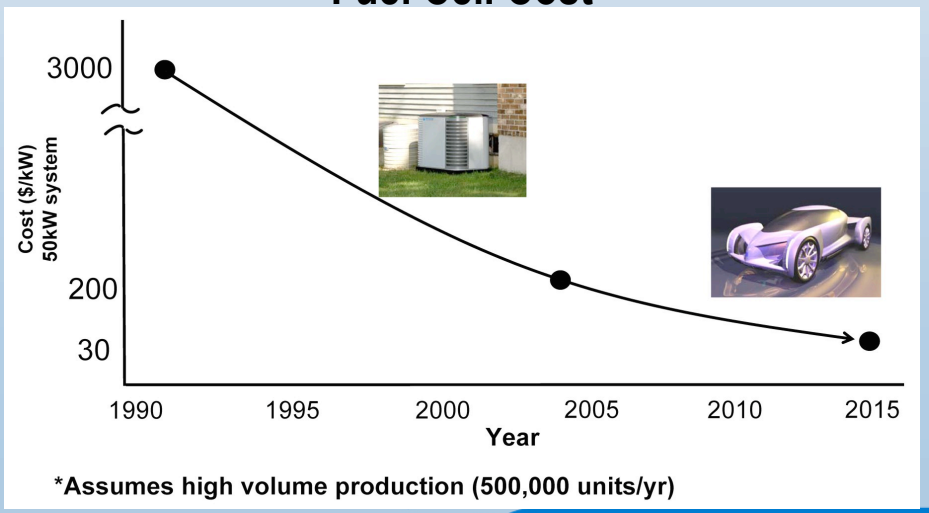
Economic/Institutional Barriers:

- Codes and Standards (Safety and global competitiveness)
- Hydrogen Delivery (Investment for new distribution infrastructure)
- Education

Storage Volume for >300 Mile Range



Fuel Cell Cost



Summary

- Biomass is our only sustainable long-term source of carbon-based liquid fuels & chemicals
- The NBC was created to help coordinate biomass research conducted at U.S. DOE Labs
  - 2 Core conversion platforms:
    - Bio-Chemical
    - Thermo-Chemical
  - Biorefinery concept development
  - Bio-product development
- Hydrogen timeline for deployment
  - Realization of Hydrogen Economy after 2030
- Barriers remain to make Hydrogen Economy tenable

Additional Information

- DOE Biomass Program Web Site
  http://www.eere.energy.gov/biomass/
- NREL Biomass Web Site
  http://www.nrel.gov/biomass/
- DOE Hydrogen Program Web Site
  http://www.hydrogen.energy.gov/


Thank You for the Opportunity
Are there any Questions ?